THE WEARY FOUNDER: SLEEP PROBLEMS, ADHD-LIKE TENDENCIES, AND ENTREPRENEURIAL INTENTIONS

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ABSTRACT

Scholars have persuasively documented the positive influence of ADHD-like tendencies (the impermanent experience of ADHD-like symptoms) on entrepreneurial intentions. Yet, we know little about the causes of ADHD-like tendencies, and thus about factors that could heighten entrepreneurial intentions *through* such tendencies. Drawing from the biopsychosocial model, sleep physiology literature, and entrepreneurship literature, we propose that the biological experience of sleep problems may heighten the psychological experience of ADHD-like tendencies, which could nudge people toward the socially-embedded intention to venture. Four studies and a mini meta-analysis provide support, extending several literatures and suggesting that sleep problems could contribute to business founding.

Key words: Sleep, ADHD-like tendencies, entrepreneurial intentions

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Why do people become entrepreneurs despite all of the associated risks? Given the societal benefits of entrepreneurship (Acs, 1999; Hitt, Ireland, Sirmon, & Trahms, 2011), this question has intrigued entrepreneurship scholars for decades (e.g., Baron, 1998; Begley & Boyd, 1987; Zhao, Seibert, & Hills, 2005). In response, studies have investigated a variety of individual differences that might prompt individuals to develop entrepreneurial intentions. For example, they have examined personality traits like risk propensity (Stewart & Roth, 2001), need for achievement (Begley & Boyd, 1987), and the Big Five (Zhao, Seibert, & Lumpkin, 2010). More recently, they have also examined neurobiological differences including genetic predispositions (Nicolaou, Shane, & Spector, 2008), prenatal testosterone exposure (Bönte, Procher, & Urbig, 2015), and neurodevelopmental disorders (Wiklund, Yu, Tucker, & Marino, 2017).

Within the research on neurodevelopmental disorders, Attention Deficit Hyperactivity Disorder (ADHD) has emerged as a notable driver of entrepreneurial intentions (e.g., Dimic & Orlov, 2014; Wiklund, Patzelt, & Dimov, 2016; Wiklund et al., 2017), i.e., the interest in engaging in prototypical entrepreneurial activities (Zhao et al., 2005). Although the combination of hyperactivity, impulsivity, and attentional variation underlying clinical ADHD could clearly hamper many workplace outcomes (Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993), entrepreneurship research has suggested that ADHD can also heighten entrepreneurial intentions. Specifically, clinical ADHD may "push" people away from standard jobs (Barkley & Murphy, 2010) and "pull" them toward a more flexible entrepreneurial lifestyle (Wiklund et al., 2016).

Since clinical ADHD is a disorder that some people have and others do not, this research falls within the literature's longstanding focus on individual differences. However, an important sub-stream within the literature focuses not on clinical ADHD but on the impermanent

experience of symptoms resembling ADHD, which we call ADHD-like tendencies (Lerner, 2016; Thurik, Khedhaouria, Torrès, & Verheul, 2016; Verheul et al., 2015). This research argues that many psychologically "normal" individuals experience ADHD-like tendencies at times, and the impermanent experience of such tendencies—whatever their source—can heighten entrepreneurial intentions. Since this view focuses on impermanent experiences, it falls outside the focus on stable individual differences, adding to a growing literature on situational drivers of intentions (Lee, Wong, & Der Foo, 2011; Shepherd & Patzelt, 2015; Mathias & Williams, 2017).

But what *are* the sources of ADHD-like tendencies? Although the answer is critical for understanding the factors that heighten entrepreneurial intentions *through* such tendencies in the real world, little research has examined this issue. The present research examines one potential antecedent of ADHD-like tendencies with particular relevance for the modern world: sleep problems. Given that we live in an increasingly sleepy age (National Institute for Occupational Safety and Health (NIOSH), 2004), with many people around the world sleeping insufficiently or poorly (e.g., 40% of American businesspeople; Groeger, Zijlstra, & Dijk, 2004; Park et al., 2010; Salminen et al., 2010), sleep problems hold great contemporary relevance. Although scholars have recently shown an interest in practicing entrepreneurs' sleep health (Kollmann, Stöckmann, & Kensbock, 2018; Murnieks et al., 2019) as well as the influence of sleep on practicing entrepreneurs' performance (Williamson, Battisti, Leatherbee, & Gish, 2019), we know of no empirical research on the relationship between sleep and entrepreneurial *intentions*—a critical initial stage in the entrepreneurial journey (McMullen & Dimov, 2013).

The current research examines whether sleep problems might contribute to entrepreneurial intentions through ADHD-like tendencies. Importantly, since ADHD-like tendencies represent an impermanent state, we study the causal role of impermanent sleep

problems too. The word “impermanent,” as opposed to “temporary” or “fleeting,” connotes that ADHD-like tendencies and sleep problems are often more variant than stable traits, but also more stable than transient states like hunger or arousal. As an example from the sleep domain, 90% of insomnia cases do not represent chronic conditions (Cleveland Clinic, 2019), but they also tend to persist for extended periods like several weeks or months (National Sleep Foundation, 2019). Findings like these suggest that sleep problems are neither as fixed as stable traits nor as transient as passing states, suggesting they could also have more than transient effects on downstream ADHD-like tendencies and entrepreneurial intentions.

Our predictions about the relationships between sleep problems, ADHD-like tendencies and entrepreneurial intentions build from the biopsychosocial model (e.g., Engel, 1977), sleep physiology literature (e.g., Krause et al., 2017), and entrepreneurship literature (e.g., Lerner, Hunt, & Dimov, 2018; Shapero, 1982). Specifically, we connect the biological phenomenon of sleep problems, the psychological experience of ADHD-like tendencies, and the socially-embedded formation of entrepreneurial intentions. These theoretical connections suggest that, although sleep problems might be expected to produce lethargy rather than hyperactivity, the biological experience of (impermanent) sleep problems may actually heighten the psychological experience of (impermanent) ADHD-like tendencies. Heightened ADHD-like tendencies, in turn, may heighten people’s intentions to engage in entrepreneurial venturing. Figure 1 illustrates the predicted relationships, which four studies spanning multiple populations and cultures support.

We believe our findings stand to make several important theoretical and practical contributions. First, they may extend the entrepreneurship literature’s nascent focus on ADHD-like tendencies by documenting a common biological driver of such tendencies. Second, since we focus on impermanent sleep problems, our work may identify sleep problems as a novel and

ubiquitous state-like antecedent of entrepreneurial intentions. Third, our work may complement the entrepreneurship (and broader management) literature's predominantly negative conclusions about the consequences of sleep problems. For example, entrepreneurship studies suggest that sleep problems result in diminished creativity (Weinberger, Wach, Stephan, & Wegge, 2018), reduced innovative behaviors (Williamson et al.,, 2019), increased exhaustion (Murnieks, Arthurs, Cardon, Farah, Stornelli, & Haynie, 2019), and impaired belief formation about ventures (Gish, Wagner, Grégoire, & Barnes, 2019). Although we allow for the possibility that ongoing and unmitigated sleep problems could hinder the longer-term success of an individual entrepreneur (Gunia, 2018), our work explores whether sleep problems might heighten entrepreneurial intentions and ultimately the rate of business venturing (Lerner et al., 2018), the latter of which has been linked to positive societal outcomes like wealth creation, increased opportunities for marginalized groups, and innovative solutions to societal problems (e.g., Acs, 1999; Hitt et al., 2011; Markman, Waldron, Gianiodis, & Espina, 2019). Finally, and in addition to these theoretical contributions, our work may hold some important practical implications for the way social commentators, instructors, and prospective entrepreneurs view sleep problems.

BIOPSYCHOSOCIAL MODEL AND ENTREPRENEURIAL INTENTIONS

Our predictions are rooted in the biopsychosocial model (Engel, 1977), which suggests that health represents a complex intertwining of biological, psychological, and social factors. Specifically, and in contrast to purely medical models that reduce health to biology, Engel proposed that a holistic understanding of health requires attention to all three factors and the relationships between them (Borrell-Carrio, Suchman, & Epstein, 2004). Several papers have since investigated interrelated biological and psychological antecedents of entrepreneurship (e.g. Levesque & Minniti, 2006; Shane, Nicolaou, Cherkas, & Spector, 2010; Zhang et al., 2009).

Following in this tradition, we examine whether the biological experience of sleep problems heightens the psychological experience of ADHD-like tendencies, and whether these tendencies influence the socially-embedded development of intentions to pursue entrepreneurship.

We use the term "socially-embedded" to convey that the development of entrepreneurial intentions occurs in social context, with possible implications for the durability of intentions heightened by sleep problems. Broadly, people form entrepreneurial intentions in the context of external enablers like sociocultural and demographic changes, so their intentions are hard to separate from their social context (Davidsson, 2015). On a micro level, individuals contemplating career changes like founding a venture tend to consult with others (Phillips, Christopher-Sisk, & Gravino, 2001). Prospective entrepreneurs in particular often discuss their thinking with people like potential customers (Shane & Venkataraman, 2000), partners (Greve & Salaff, 2003), and funders (Hallen & Eisenhardt, 2012). This socially-embedded process fits within the biopsychosocial model, in turn, because venturing holds numerous implications for an individual's physical and mental health (Stephan, 2018). In sum, although entrepreneurship may be "less social" than working in organizations (Wiklund et al., 2016), the development of entrepreneurial intentions is still socially-embedded, meaning that it may interrelate with health-related biological factors like sleep and psychological factors like ADHD-like tendencies.

ADHD-LIKE TENDENCIES AND ENTREPRENEURIAL INTENTIONS

Starting on the right side of Figure 1, an emerging literature studies the relationship between ADHD and entrepreneurial intentions. One stream of the literature has focused on the causal role of clinical ADHD (e.g., Dimic & Orlov, 2014; Wiklund et al., 2016), defined as "a developmental disorder characterized by ample energy in the form of severe and persistent hyperactivity and distractibility that is essentially driven by behavioral 'disinhibition' or a lack of

restraint" (Verheul et al., 2015: 86). Consistent with clinical ADHD research, entrepreneurship work in this stream compares the venturing behavior of people who do or do not "have" ADHD.

As noted, we build from another stream of the entrepreneurship literature focused on the impermanent experience of ADHD symptoms, i.e., ADHD-like tendencies (Lerner, 2016; Thurik et al., 2016; Verheul et al., 2015). Consistent with the clinical definition, this stream has identified three specific ADHD-like tendencies: "(hyper)activity, a proclivity to act on impulse [impulsivity], and attentional variation" (Lerner, 2016: 237). In a departure from the clinical ADHD literature, this stream suggests that many psychologically "normal" individuals experience and display hyperactive, impulsive, and inattentive tendencies over particular periods of time, without necessarily having clinical ADHD. Additionally, it measures these tendencies using a continuous scale rather than a dichotomous classification system, focusing on the impact of greater or lesser ADHD-like tendencies rather than having or not having the disorder. While isolated experiences of ADHD-like tendencies may not lead people to found businesses, the literature suggests that more extended (i.e., impermanent) experiences may nudge people toward entrepreneurship by contributing to heightened entrepreneurial intentions (Verheul et al., 2015).

These ideas are rooted in the assumption that the mechanisms associated with clinical ADHD may also operate on an impermanent basis. Specifically, ADHD-like tendencies may, for a time, reduce the desirability of traditional jobs with rules, routines, and oversight ("push" mechanism; Barkley & Murphy, 2010; Verheul et al., 2015) and increase the desirability of flexible and autonomous careers like entrepreneurship ("pull" mechanism; Wiklund et al., 2016). In sum, even impermanent experiences of ADHD-like tendencies may subjectively decrease the appeal of traditional work and increase the appeal of entrepreneurship, nudging people toward entrepreneurship by heightening their entrepreneurial intentions. Thus, we first seek to replicate:

H1: ADHD-like tendencies will be positively associated with entrepreneurial intentions.

THE ROLE OF SLEEP PROBLEMS

ADHD-like tendencies are not assumed to reflect individual differences, only how an individual feels and behaves for a particular period of time. Our research investigates the potentially causal role of a biological factor: impermanent sleep problems. Sleep is a recuperative biological process governed by two largely independent processes (homeostatic and circadian; e.g., Owens et al., 2013). The homeostatic process involves a steady accumulation of "sleep pressure" during waking hours and the dissipation of sleep pressure during sleep. Accordingly, poor or insufficient prior sleep increases the present drive to fall asleep (e.g., Borbély, 1982). Circadian processes, in turn, involve predictable cycles of sleepiness (culminating in circadian troughs) and wakefulness (culminating in circadian peaks) throughout the 24-hour period. Together, homeostatic and circadian processes govern when individuals fall asleep as well as how long and how well they sleep.

Sleep problems, which can arise from disruptions to homeostatic or circadian processes as well a variety of more distal sources (e.g., poor sleeping conditions), are typically conceptualized to encompass an array of impairments ranging from difficulty falling or staying asleep; to interrupted, disturbed, or restless sleep; to insufficient sleep duration (e.g., Paavonen et al., 2000). Since this array of impairments is often summarized as problems with sleep quality or quantity (Barnes, 2012), and since quality and quantity represent parallel albeit comorbid indicators of unhealthy sleep (Barnes et al., 2011), we study and use the term "sleep problems" to encompass both. Although sleep problems can trace to chronic sleep disorders like restless leg syndrome (Walters, 1995) and obstructive sleep apnea (Young, Peppard, & Gottlieb, 2002), our focus on impermanent ADHD-like tendencies leads to a parallel focus on impermanent sleep problems, which, as noted, are common (NIOSH, 2004).

How might such sleep problems contribute to ADHD-like tendencies? Two distinct bodies of research pertain to this question. Notwithstanding our focus on impermanent conditions, the first is research on the link between clinical ADHD and clinical sleep disorders (for a review, see Owens et al., 2013). The voluminous literature in this area tends to study children with clinically diagnosed ADHD, suggesting that such children also show an elevated incidence of clinical sleep disorders and their symptoms (e.g., Lunsford-Avery, Krystal, & Kollis, 2016; Owens, 2005; Owens et al., 2013). This comorbidity indicates a potential relationship between clinical ADHD and clinical sleep problems, but the precise direction of the relationship is complex and difficult to disentangle (Owens et al., 2013). Reasons include ethical considerations, which tend to preclude controlled studies that definitively document a causal order, and the fact that clinical ADHD and clinical sleep disorders tend to encompass many of the same behavioral symptoms and neurological correlates (e.g., in brain regions associated with attention and executive functioning like the prefrontal cortex; Owens et al., 2013).

In sum, the causal relationship between clinical ADHD and clinical sleep disorders remains unclear, leading one scholar to represent the relationship in four possible theoretical models ranging in directionality (Hvolby, 2015). Thus, although the clinical literature is notable for studying ADHD and sleep symptoms meticulously and documenting overlap between them, two critical questions remain: First, do sleep and ADHD have a causal relationship, and, if so, what is its direction? Second, do the relationships documented in the clinical literature extend from clinical disorders in children to impermanent ADHD-like tendencies and sleep problems among nonclinical adults? Building from a second relevant body of research—the sleep physiology literature—and a conceptual paper on sleep and entrepreneurship (Gunia, 2018), we seek to develop theory on and provide empirical answers to these questions.

In contrast to the clinical literature, the sleep physiology literature does study nonclinical adults and sometimes documents causal effects of sleep problems, impermanent or otherwise, on discrete behaviors. However, this literature does not generally link these behaviors to ADHD, meaning it cannot study the causal effect of sleep problems on ADHD-like tendencies. Since we know of no other research that studies the causes of ADHD-like tendencies (other than clinical ADHD itself), we seek to do so here by weaving together relatively fragmented strands from the sleep physiology literature. In particular, this literature has documented causal relationships between sleep problems and several discrete behaviors that bear a "family resemblance" to each of the ADHD-like tendencies (hyperactivity, impulsivity, and attentional variation).

For example, in terms of hyperactivity, sleep problems tend to prompt riskier choices (Hockey, Maule, Clough, & Bdzola, 2000; Killgore, Kamimori, & Balkin, 2011) and a focus on gain promotion vs. loss prevention (Venkatraman, Huettel, Chuah, Payne, & Chee, 2011), both of which are common among hyperactive individuals (Drechsler, Rizzo, & Steinhausen, 2008; Olazagasti et al., 2013; Weiss & Murray, 2003; Venkatraman, Chuah, Huettel, & Chee, 2007). Consistent with impulsivity, sleep problems elicit incorrect responding (Anderson & Platten, 2011), aggressive outbursts (Kamphuis, Dijk, Spreen, & Lancel, 2014), and overweighting of present payoffs (Reynolds & Schiffbauer, 2004). Finally, consistent with attentional variation, sleep problems tend to result in distraction (Chuah et al., 2010) and impaired attention maintenance (Krause et al., 2017). Integrating these discrete findings from sleep physiology, we predict and collect the first known data to test whether impermanent sleep problems causally elicit ADHD-like tendencies among nonclinical adults (phrasing the hypothesis conservatively and consistently with the other hypotheses despite our causal prediction):

H2: Sleep problems will be positively associated with ADHD-like tendencies.

To the extent that ADHD-like tendencies are associated with heightened entrepreneurial intentions (H1) and sleep problems are associated with ADHD-like tendencies (H2), sleep problems would be expected to heighten entrepreneurial intentions through ADHD-like tendencies. But could sleep problems also affect entrepreneurial intentions independently of ADHD-like tendencies? Drawing from Shapero's (1982) model of the entrepreneurial event (SEE) to theoretically elucidate some alternative causal processes, we suggest they could.

In brief, SEE suggests that individuals' entrepreneurial intentions represent a function of three factors: their perceptions of the desirability and feasibility associated with pursuing an entrepreneurial idea or career and their "propensity to act." Desirability is the extent to which an individual finds the pursuit of an entrepreneurial idea and its anticipated outcomes personally attractive (both in general and compared to alternative arrangements). Feasibility represents how capable the individual feels of pursuing the idea and attaining the outcomes. Propensity to act represents the individual's likelihood of acting on their decisions. SEE is similar to other intention-based models like the Theory of Planned Behavior (Ajzen, 1991) but also differs in several ways—especially its omission of "social norms" as an explicit predictor of intentions, its specificity to entrepreneurship, and potentially its greater explanatory power in the entrepreneurship domain (Krueger, Reilly, & Carsud, 2000).

In keeping with SEE, we theoretically propose that sleep problems could heighten entrepreneurial intentions by influencing perceptions of the desirability and feasibility of pursuing existing entrepreneurial ideas as well as heightening the propensity to act. First, sleep problems might cause individuals to feel relatively "pushed" out of traditional organizational settings, which could increase the comparative desirability of entrepreneurship. In traditional organizational settings, work is highly interdependent and interactive (Ferrin et al., 2009). A

variety of evidence, however, suggests that sleep problems engender socially-oriented difficulties that could make individuals feel relatively averse to such settings. For example, individuals experiencing sleep problems tend to have greater difficulty with (Killgore et al., 2008)—and experience more conflict in—interpersonal interactions (Gordon & Chen, 2014). They also extend less trust (Anderson & Dickinson, 2010), exert less effort in group tasks (Hoeksema-van Orden, Gaillard, & Buunk, 1998), and demonstrate less awareness of their unethical behavior (Barnes, Gunia, & Wagner, 2015). Collectively, difficulties like these could decrease the perceived desirability of standard work arrangements and increase the perceived desirability of alternative arrangements like pursuing an entrepreneurial idea (or not working) by comparison.

In addition, sleep problems could theoretically cause individuals to feel "pulled" toward entrepreneurial settings by factors that increase the perceived desirability and/or feasibility of acting on an entrepreneurial idea. One reason is that entrepreneurial careers often involve sleeping at unconventional times and places. People with sleep problems might find such a lifestyle more desirable (Wiklund et al., 2016) and/or a career involving sporadic sleep more feasible. Additionally, individuals with sleep problems may be particularly attuned and attracted to the presumed economic prospects associated with pursing entrepreneurial ideas—particularly the presumed prospect of a short-term payoff. Indeed, sleep problems tend to elicit a focus on and heightened preference for rapid payoffs (Libedinsky et al., 2011; Mullin et al., 2013), and sleepy individuals tend to work particularly hard when motivated by the prospect of a short-term reward (Hsieh, Li, & Tsai, 2010). In short, sleepy individuals' focus on present payoffs (Reynolds & Schiffbauer, 2004) may heighten the desirability of pursuing a short-term payoff by commercializing an entrepreneurial idea, as opposed to slowly saving out of a periodic paycheck. Such a prospect is obviously risky, and the presumed payoffs may not materialize. Yet, sleepy

individuals' overweighting of gains (Venkatraman et al., 2011), underweighting of risks (e.g., Killgore et al., 2011), and reduced attention to consequences (Dijk, 2011) may cast the pursuit of an entrepreneurial idea as not only more desirable but more feasible. Enhanced perceptions of feasibility and any associated overconfidence, in turn, could theoretically heighten entrepreneurial intentions (Koellinger, Minniti, & Schade, 2007). Consistent with these possibilities, initial evidence suggests that sleep loss licenses people to abandon established career goals and strike out on a riskier path (Scullin & McDaniel, 2010).

Finally, and in addition to heightening entrepreneurial intentions by making entrepreneurship seem more desirable and/or feasible, sleep problems could theoretically heighten SEE's third driver of intentions: individuals' propensity to act (Shapero, 1982). This driver of intentions fits with a recent trend in the entrepreneurship literature, which suggests that entrepreneurial intentions can arise from a variety of factors, some rational and deliberative and some a-rational and impulsive (Hunt & Lerner, 2018; Lerner et al., 2018; Shepherd, 2015). This work does not minimize the importance of rational, deliberative analysis in the formation of entrepreneurial intentions—"System 2" processes (Kahneman, 2011) traditionally modeled by rational theories like SEE. Indeed, it suggests that individuals can and do form entrepreneurial intentions based on rational analysis. Yet, this work suggests that a variety of a-rational impulses—"System 1" processes—often complement rational considerations by nudging people to transform decisions into actions rather than engaging in indefinite deliberation. This research identifies a variety of momentary influences ranging from emotions (Cardon, Foo, Shepherd, & Wiklund, 2012), to contagion (Hunt, 2015), to luck (Dew, 2009) that can shift individuals from considering an idea to acting on it. Although a-rational factors are not generally discussed in relationship to SEE and SEE's "propensity to act" factor is often measured as an individual

difference, we link a-rational factors to SEE by suggesting that such factors may increase individuals' propensity to act for an impermanent period of time. Thus, we generally suggest that a-rational influences may heighten entrepreneurial intentions through the propensity to act factor in SEE. More specifically, we build theory suggesting that, since sleep problems shift people's preferences away from deliberation toward action (Anderson & Platten, 2011; Drummond, Paulus, & Tapert, 2006), such problems may *be* an a-rational influence that heightens entrepreneurial intentions through the propensity to act.

Collectively, these considerations suggest that individuals experiencing (impermanent) sleep problems may find the pursuit of an entrepreneurial idea relatively more desirable and feasible, and they may show a heightened propensity to act. Thus, SEE provides a theoretical basis for suggesting that sleep problems may heighten entrepreneurial intentions, which in combination with the prior predictions suggests the triangular relationship in Figure 1:

H3: Sleep problems will be positively associated with entrepreneurial intentions.

H4: ADHD-like tendencies will mediate the relationship between sleep problems and entrepreneurial intentions.

Finally, we note that, since impermanent sleep problems can often last several weeks or months (National Sleep Foundation, 2019), their effects may be more than transient. Instead, some individuals experiencing sleep problems over weeks or months may take initial steps to actualize their entrepreneurial intentions—steps that, since they involve the dissolution or formation of relationships (e.g., quitting a job, getting a business loan, forming a business partnership), are both socially-embedded and hard to reverse. In support, research suggests that the early stages of the entrepreneurial process and especially the activities involved in accumulating resources are social in nature

(Baron & Shane, 2004; Greve & Salaff, 2003) and can sometimes unfold over periods of time as brief as "a few minutes to a few days" (Scarbrough, Swan, Amaeshi, & Briggs, 2013: 1216). Even if an individual's sleep problems dissipate after a few weeks or months, socially-embedded steps like these could be hard to reverse, particularly if they involve a contract. This all suggests that impermanent sleep problems, while probably insufficient to explain business founding on their own and unlikely to last longer than a few months, could cause people to take relatively irreversible steps on behalf of long-held entrepreneurial aspirations, setting off a chain of intentions and actions.

THE CURRENT RESEARCH

Our four studies seek to empirically test the relationships among sleep problems, ADHD-like tendencies, and entrepreneurial intentions. Study 1 provides experimental evidence that the impermanent experience of sleep problems causally precipitates ADHD-like tendencies. Studies 2-3 test the full indirect model in Figure 1 among panels of adults and explore some alternative mediators. Study 4 broadens our analysis by testing whether the mediated relationship emerges among a global panel of individuals with entrepreneurial experience and extends to their intentions to found additional businesses, as many entrepreneurs do (Westhead & Wright, 1998). Across studies, we used several measures of entrepreneurial intentions to enhance generalizability. All sample sizes or sample groups were determined in advance.

STUDY 1

Study 1 sought to establish a causal relationship between impermanent sleep problems and ADHD-like tendencies. Thus, we conducted an experiment that did or did not deprive individuals of sleep and then prompted them to report their ADHD-like tendencies.

Method

Participants and Design. Based on a G*Power analysis (Faul, Erdfelder, Lang, & Buchner, 2007), we set the *a priori* goal of recruiting 232 participants from Prolific Academic, an international, online panel of adult respondents. Participants were randomly assigned to one of two conditions: Sleep Deprivation or Control. As detailed below, individuals in the Control condition completed a pre-survey, then a post-survey the next day. Individuals in the Sleep Deprivation condition completed these two surveys plus ten intervening overnight surveys, each hour on the hour from 10 pm to 7 am the next day, which served to deprive them of sleep (following Barnes, Gunia, & Wagner, 2015). Given this procedure, we sought to eliminate any confusion about time by recruiting participants from a country with a single time zone: the U.K. To assure equal financial benefits across conditions, participants' pay was scaled to be about the same on an hourly basis: Participants in the Control condition earned $2 (~1.54 GBP), while those in the experimental condition earned $8 (~6.14 GBP) due to the greater time commitment.

Despite higher absolute pay (but equal hourly pay) in the Sleep Deprivation condition, prior research led us to suspect that participants in that condition would get fatigued and drop out of the study at an elevated rate (Barnes et al., 2015). They did: About 45% of the participants in the Sleep Deprivation condition started the study but did not complete the minimum number of overnight surveys (see below) or post-survey, whereas about 19% of the participants in the Control condition did not complete the post-survey. Below, we deal with dropout and potential selection bias by testing whether the demographics and pre-survey responses of the final set of participants varies between conditions. To maintain random assignment despite differing dropout rates, we had to over-recruit participants and ended up with more than initially sought (N = 350) as well as unbalanced cells (133 in the Sleep Deprivation condition, 217 in the Control condition). Below, we deal with unbalanced cells by rerunning the primary analysis using a

randomly-selected, equally-sized subset of participants from the Control condition. Among the final 350 participants, 61.8% were female, and they averaged 37.5 years old (*SD* = 11.4). We are unsure why the final sample was majority-female and test for gender effects below.

Procedure. Participants in both conditions were recruited for an "Overnight Study" (with no initial reference to sleep, ADHD, or entrepreneurship). They were clearly informed that they might be assigned to either of two "groups": one that would require them to complete two surveys on consecutive days (the second at 8 am), and one that would require them to complete these two surveys plus ten intervening overnight surveys, each hour on the hour from 10 pm until 7 am the next day. All surveys would be completed online at a location of participants' choosing (presumably their home for the overnight surveys). Participants also received full information in advance on the compensation rates in each condition, subject to the requirement that they completed both surveys (Control condition), or the pre- and post-survey plus at least seven of the overnight surveys (Sleep Deprivation condition). Before learning their condition, participants were asked to quit the study if they did not anticipate the ability to comply with either condition.

Participants who continued completed the pre-survey questions below. Finally, they learned their condition. Participants in the Sleep Deprivation condition read more about the overnight surveys, whereas those in the Control condition were asked to complete the 8 am survey the next day (see Appendix A). Finally, everyone provided their Prolific email address.

At 10 pm the same day, participants in the Sleep Deprivation condition received an email containing the first of ten overnight surveys. The survey prompted them to enter their unique identifier and complete the affect measure below. Participants in this condition then received nine additional, online surveys each hour on the hour until 7 am the next day. To receive "credit" for taking each survey, participants were required to wake themselves up and complete the affect

measure within 15 minutes of receipt. The primary purpose of these surveys was to disrupt participants' sleep patterns (following Barnes et al., 2015), and we did not intend to analyze the affect data contained therein. Finally, at 8 am the next day, participants in both conditions received and completed the post-survey, consisting of the measures below.[1] Participants who completed the requisite surveys were compensated online within 24 hours.

Measures

Sleep problems (pre- and post-surveys). Since self-reports of sleep quality and quantity correlate with objective measures (Barnes et al., 2011), participants were asked to self-report their sleep quality and sleep quantity. In the pre-survey, these questions referred to their sleep patterns over the last six months; in the post-survey, they referred to the prior evening. Sleep quality was measured via two sets of items adapted from the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989); they were compiled into a sleep quality index (α_{pre} = .89; α_{post} = .89). The second set of items measured an indirect indicator of sleep quality: insomnia symptoms (Jenkins, Stanton, Niemcryk, & Rose, 1988; α_{pre} = .75; α_{post} = .77). Sleep quantity was calculated using a series of questions adapted from the PSQI (Buysse et al., 1989). Appendix B lists the exact wording of all sleep questions across studies.

ADHD-like tendencies (pre- and post-surveys). Participants responded to the 18 items in a clinically-validated measure of ADHD (World Health Organization Adult ADHD Self-Report Scale [ASRS]), as applied to impermanent time periods. Following prior entrepreneurship research (e.g., Verheul et al., 2015), responses were expected to indicate participants'

[1] Since homeostatic and circadian processes operate independently, as explained in the introduction, we expected sleep-deprived participants (who experienced a disruption of homeostatic processes) to be sleepier at 8 am on average, irrespective of their circadian cycle. Put differently, we expected "morning" and "evening" people to be randomly distributed across conditions due to our random assignment procedure, which should lead to heightened average sleepiness in the Sleep Deprivation condition.

impermanent psychological experiences with ADHD symptoms, i.e., their ADHD-like tendencies. In the pre-survey, the items referred to their behavior over last six months, asking, for example: "How often do you feel restless or fidgety?" (1= Never, 5 = Very often). In the post-survey (administered at 8 am of day 2), participants indicated whether the items would describe their behavior in the day ahead, responding to a prospectively-worded version of the scale. For example: "Will you feel restless or fidgety?" (1= Definitely not, 5 = Definitely. The questions were asked at this time, in this way, because we anticipated that asking them later in the day would lead to excessive participant dropout. Since we expected participants to answer these questions by reflecting on their current psychological state, we expected their responses to indicate their current ADHD-like tendencies. The pre- and post- questions were each compiled into ADHD-like tendencies scales (α_{pre} = .87; α_{post} = .88). For comparability with Studies 3-4, which use a common, shortened version of the measure (i.e., the ASRS-6; Kessler et al., 2005), we also examined the short scale here (α_{pre} = .70; α_{post} = .71).

Affect (overnight and post-surveys). In each of the overnight surveys as well as the post-survey, participants completed the 10-item short form of the PANAS (e.g., by indicating how much they feel "upset"; 1 = Does not describe how I feel to 7 = Describes how I feel extremely well; Thompson, 2007). As noted, we did not analyze the overnight affect data. Based on Williamson et al.'s (2019) observation that affect may explain various workplace outcomes and mediate the relationship between sleep and those outcomes, however, we computed positive (α = .88) and negative (α = .90) affect scales from the post-survey data and assessed whether affect might provide an alternative or complementary explanation for our results.

Demographics and control variable (pre- and post-surveys). Given the strong impact of individual differences in chronotype on sleep-related behaviors (Gunia, Barnes, & Sah, 2014),

the pre-survey measured participant chronotype (1 = morning person to 7 = evening person), and our analyses controlled for it. The post-survey concluded with a series of demographic questions.

Analyses

We first test for potential selection bias as a result of differential dropout rates across conditions, then examine the manipulation's efficacy. Given pre-survey data on participants' chronic ADHD-like tendencies, coupled with some amount of between-person differences in these tendencies (Verheul et al., 2015), our primary analysis consisted of a 2(Condition: Sleep Deprivation vs. Control) x 2(pre vs. post) mixed between-within ANOVA, with the first factor between-subjects and the second within-subjects, on participants' post-survey ADHD-like tendencies. In essence, this analysis controls for between-person differences in ADHD-like tendencies, assessing the extent to which the sleep problems prompted by the manipulation increase those tendencies within-person. To deal with unequal cell sizes, we rerun this analysis using a randomly-selected, equally-sized subset of Control participants.

Results

Sample comparability and manipulation check. The final set of participants did not vary significantly across conditions in pre-survey ADHD-like tendencies ($p = .14$), sleep quality ($p = .15$), insomnia ($p = .77$), or sleep quantity ($p = .60$). They also did not vary in demographics, as assessed in the post-survey: age ($p = .19$), gender ($p = .27$), years speaking English ($p = .15$). This lack of demographic differences suggests that selection bias is unlikely to influence our results, despite the elevated dropout inherent to the sleep deprivation paradigm.

The post-survey sleep data supported the manipulation. Participants in the Sleep Deprivation condition reported lower sleep quality ($M_{deprivation} = 2.38$, $SD_{deprivation} = .94$; $M_{control} = 3.17$, $SD_{control} = 1.09$; $t(348) = 6.91$, $p < .001$), more insomnia ($M_{deprivation} = 3.05$, $SD_{deprivation} =$

1.06; $M_{control}$ = 2.39, $SD_{control}$ = 1.05; $t(348) = 5.64$, $p < .001$), and lower sleep quantity ($M_{deprivation}$ = 6.11, $SD_{deprivation}$ = 1.96; $M_{control}$ = 6.66, $SD_{control}$ = 1.63; $t(348) = 2.82$, $p = .005$). Despite these results, a close examination of the sleep quantity data revealed that a subset of participants in the Sleep Deprivation condition reported spending little or no time awake. Since overnight survey completion required them to spend a bare minimum of ~30 minutes awake (~4 minutes per survey x at least 7 surveys, plus any time required to fall back asleep), these participants effectively did not receive the sleep deprivation manipulation. To be both transparent and conservative, we present the main analysis both with and without the 49 participants in the experimental condition who reported that they spent less than 30 minutes awake.

Main analysis. Gender had no effects on the primary dependent variables in this or any of our other studies and will not be discussed further. H2 suggested that sleep problems would elicit elevated ADHD-like tendencies. In general support, a 2 x 2 mixed ANOVA on the full ADHD-like tendencies scale, using the full sample of participants, produced a marginally-significant interaction between condition and pre- or post-survey ADHD-like tendencies (and no other effects), $F(1,347) = 3.61$, $p = .058$. Participants in the Sleep Deprivation condition reported greater ADHD-like tendencies in the post- than the pre-survey, whereas those in the Control condition reported the opposite (see Figure 2). The same ANOVA on the ADHD-like tendencies short scale, in turn, was significant and reflected the same pattern, $F(1,347) = 4.45$, $p = .04$.

Excluding participants in the Sleep Deprivation condition who failed the manipulation check, the results of both ANOVAs were significant and reflected the same pattern; full ADHD-like tendencies scale: $F(1,298) = 11.87$, $p < .001$; short scale: $F(1,298) = 12.20$, $p < .001$. Finally, using the same subset of Sleep Deprivation participants and randomly selecting an equally-sized subset from the Control condition ($N = 84$) to account for unequal cell sizes, both ANOVAs

remained significant and reflected the same pattern: full ADHD-like tendencies scale: $F(1,165) = 5.25$, $p = .02$; short scale: $F(1,165) = 8.15$, $p = .005$. (All analyses produced the same pattern, but Figure 2 depicts this last result.) Importantly, none of these effects appeared attributable to sleep-deprived participants' reduced positive or increased negative affect (as reported on the post-survey), as participants did not differ between conditions on the former, $t(348) = 1.21$, $p = .24$, and sleep-deprived participants actually reported *less* negative affect, $t(348) = 4.34$, $p < .001$.

Discussion

This study provided experimental evidence for a causal relationship between sleep problems and ADHD-like tendencies, supporting H2. This effect was robust to several model specifications and sample subsets.[2] Our remaining studies turn to validating the full model proposed by H1-H4—the next two studies by administering surveys to differing panels of adults.

STUDY 2

Method and Measures

Participants. We recruited participants for a study about decision-making (with no reference to sleep, ADHD, or entrepreneurship) from Amazon's Mechanical Turk (MTurk) service: a set of people characterized as more diverse and representative of the American population than student samples, and at least as reliable (e.g., Buhrmester, Kwang, & Gosling, 2011). We set the *a priori* goal of recruiting 300 participants but ended up with 299 (62.2% Men;

[2] Following the recommendations of our review team, we sought to replicate Study 1 using a retrospective measure of ADHD-like tendencies and including a measure of entrepreneurial intentions. This follow-up study sought to: 1) test H1 with a measure of actual rather than anticipated ADHD-like tendencies and 2) provide causal evidence for all hypothesized relationships. The first goal required us to collect data on ADHD-like tendencies in the evening (7 pm) versus morning (8 am) of day 2. As reported in Appendix C, this long lag led to selective attrition in which a disproportionate number of healthy sleepers dropped out of the Sleep Deprivation condition. In other words, healthy sleepers were differentially represented in the two conditions—a failure of random assignment that prevented us from drawing causal inferences based on condition. As indicated in Appendix C, we dealt with this issue in two ways, both of which leant general support to our hypotheses.

M age = 33.9 years, *SD* = 9.7), who completed this study in exchange for $1.00. Of these, 18 failed an attention check (a typical percentage for Mturk) and were excluded, leaving 281.

Procedure. Participants completed two measures of entrepreneurial intentions, followed by measures of ADHD-like tendencies, depressive symptoms (a potential alternative mediator; Gunia, 2018), and sleep problems. Finally, they completed some demographic questions.

Entrepreneurial intentions. Participants completed Zhao et al.'s (2005) four-item measure of entrepreneurial intentions. For example, they indicated how much interest they had in "Starting a business" (1 = Very little to 5 = Very much). To make sure any effects obtained were not specific to this one scale, participants also completed the six-item Liñán & Chen (2009) measure (e.g., "I am ready to do anything to be an entrepreneur"; 1 = total disagreement to 7 = total agreement; α = .97). Although these were separate scales, a factor analysis indicated that all questions from both scales loaded onto a single factor explaining 74.11% of the variance. Thus, they were compiled into a single entrepreneurial intentions scale (α = .96).

ADHD-like tendencies. Participants completed the same 18-item measure of ADHD-like tendencies as in Study 1 (α = .93), and we again computed the six-item short scale (α = .82).

Depressive symptoms. Though the focus of the current (and prior) research on this topic is/was ADHD-like tendencies, Gunia (2018) suggested that sleep problems might also heighten entrepreneurial intentions through mild depressive symptoms, and depressive symptoms may sometimes correlate with ADHD-like tendencies. To explore this alternative mediator and correlate, current participants completed a clinically-validated six-item measure of depressive symptoms (Kroenke et al., 2009), as experienced over the last six months. (The original measure includes eight items, but we dropped two that mentioned sleep or fatigue to avoid conceptual

overlap.) For example, participants indicated the extent to which they: "Had little interest or pleasure in doing things" (1 = Not at all to 4 = Nearly every day; $\alpha = .91$).

Sleep problems. Participants completed the same sleep items as in Study 1 ($\alpha_{\text{sleep quality}} = .87$; $\alpha_{\text{insomnia}} = .84$; see Appendix B).

Control variable. As in Study 1, we controlled for participants' chronotype.

Results

To test Hypotheses 1-4, our main tests comprised three mediation models using the PROCESS Macro for SPSS (Model 4; Hayes, 2013): one with sleep quality, one with insomnia, and one with sleep quantity as the predictor. In the model with sleep quality, the proposed indirect relationship was supported: the ADHD-like tendencies scale positively predicted the entrepreneurial intentions scale (*coeff.* = .28, *SE* = .13, CI = [.02, .53]; H1), sleep quality negatively predicted the ADHD-like tendencies scale (*coeff.* = -.22, *SE* = .05, CI = [-.31, -.12]; H2), and the overall confidence interval for the indirect effect excluded zero [-.13, -.004] (H4). Unexpectedly, the direct effect of sleep quality on entrepreneurial intentions was positive both before ($\beta = .26$, *SE* = .11, *t* = 1.48, *p* = .01) and after controlling for the mediator (*coeff.* = .30, *SE* = .10, CI = [.09, .50]; H3). The model with insomnia produced similar results: the ADHD-like tendencies scale positively predicted the entrepreneurial intentions scale (*coeff.* = .31, *SE* = .13, CI = [.05, .58]; H1), insomnia positively predicted the ADHD-like tendencies scale (*coeff.* = .27, *SE* = .04, CI = [.18, .36]; H2), and the overall confidence interval for the indirect effect excluded zero [.01, .17] (H4). Similar to above, the direct effect of insomnia on entrepreneurial intentions was negative (*coeff.* = -.31, *SE* = .11, CI = [-.52, -.11]; H3).[3] In the model with sleep quantity, all

[3] In both of these models, confidence intervals for the effects of chronotype on both ADHD-like tendencies and entrepreneurial intentions included zero. Additionally, though unexpected, we recognize that the direction of the direct effects between sleep quality / insomnia and entrepreneurial intentions could be consistent with the lethargy argument stated above. Our uncertainty on this point was a primary motivator for conducting Study 3.

focal relationships including the overall indirect effect had confidence intervals including zero, suggesting that the indirect relationship did not hold. For comparability with subsequent studies, we note that the six-item short scale of ADHD-like tendencies produced similar results.

Finally, parallel mediation models for sleep quality and sleep quantity, replacing the ADHD-like tendencies scale with the depressive symptoms scale, produced confidence intervals including zero. This suggests depressive symptoms did not function as an alternative mediator.

Discussion

This study supported H1, H2, and H4 for both indicators of sleep quality. However, the direct effect of both indicators on entrepreneurial intentions was in a direction opposite to H3, and the model with sleep quantity as a predictor was not significant. Given our uncertainty about the source of these anomalies, coupled with supportive indirect effects involving sleep quality, we conducted a replication and extension study that also tested a different alternative mediator.

STUDY 3

Method and Measures

Participants. We recruited 100 adult participants for a study about decision-making (with no reference to sleep, ADHD, or entrepreneurship) from Qualtrics Research platform (17% men; *M* age = 40.1 years, *SD* = 16.6). They completed the study in exchange for compensation determined by Qualtrics. Although we did not specifically recruit females and are unsure why the final panel turned out that way, this sample provides fortuitous evidence of generalizability given the majority-male samples in two of our other studies.

Procedure. Participants completed a series of measures similar to the last study, answered some questions for a different line of research (unrelated to sleep, ADHD, or entrepreneurship), and reported their demographics.

Sleep problems. Participants completed the same sleep quality (α = .81) and insomnia (α = .77) measures as in the prior study. To minimize survey length (given the questions for another project), we used a single-item measure of sleep quantity (see Appendix B).

Entrepreneurial intentions. Participants completed the Zhao et al. (2005) entrepreneurial intentions scale from Study 2 (α = .90).

ADHD-like tendencies. Participants completed the six-item ASRS short form (α = .71).

Alternative mediator. To again explore the possibility that individuals with sleep problems might experience more negative or less positive affect (as well as ADHD-like tendencies), we examined whether affect served as an alternative mediator. As in Study 1, participants completed the short-form PANAS (Thompson, 2007; $\alpha_{positive}$ = .79; $\alpha_{negative}$ = .81).

Control variables. As in prior studies, we controlled for participant chronotype. Since entrepreneurial self-efficacy (ESE) has been linked to a preference for entrepreneurship, goal salience, determination, and performance (Stumpf, Brief, and Hartman, 1987), we also suspected that ESE might account for some variance in entrepreneurial intentions. Thus, this study also controlled for a measure of ESE (Zhao et al., 2005); results were similar without this control.

Results

To test the hypotheses, we ran the same three mediation models as in Study 2. Here too, the indirect relationship was supported for the model involving sleep quality. The ADHD-like tendencies scale positively predicted the entrepreneurial intentions scale (*coeff*. = .33, *SE* = .16, CI = [.005, .65]; H1), the sleep quality scale negatively predicted the ADHD-like tendencies scale (*coeff*. = -.14, *SE* = .07, CI = [-.27, -.002]; H2), and the overall confidence interval for the indirect effect excluded zero [-.1644, -.0009] (H4). Additionally, in this case, the direct effect of sleep quality on entrepreneurial intentions, which was negative before accounting for ADHD-

like tendencies (β = -.25, *SE* = .11, *t* = -2.35, *p* = .02; H3), had a confidence interval including zero after accounting for those behaviors, CI = [-.42, .006]).[4] This supports all four hypotheses.

In the models with insomnia and sleep quantity as predictors, however, the focal relationships and indirect effects generally had confidence intervals including zero. The two exceptions were the relationship between insomnia and ADHD-like tendencies (*coeff*. = .25, *SE* = .06, CI = [.14, .36]; H2) and the relationship between ADHD-like tendencies and entrepreneurial intentions in the sleep quantity model (*coeff*. = .37, *SE* = .16, CI = [.04, .69]; H1). Likewise, analyses of the alternative affect mediators produced overall indirect effects with confidence intervals including zero, suggesting again that neither positive nor negative affect explained the relationship between sleep problems and entrepreneurial intentions.

Discussion

The study replicated the sleep quality results from Study 2 in a different sample. In support of H1-H4, poor sleep quality was associated with heightened ADHD-like tendencies, which was associated with heightened entrepreneurial intentions; poor sleep quality was also directly associated with heightened entrepreneurial intentions. These relationships generally did not hold, however, for insomnia, sleep quantity, or several alternative mediators (though H2 held in the insomnia model and H1 in the sleep quantity model). We return to the unexpected lack of insomnia and sleep quantity effects below.

A final study sought to broaden our analysis by testing whether the mediated relationship might extend from prospective to practicing entrepreneurs. Why practicing entrepreneurs? We explicitly focused on this group for several reasons. First, many individuals intend to found

[4] Confidence intervals for the effects of chronotype and ESE on ADHD-like tendencies, as well as the effect of chronotype on entrepreneurial intentions, included zero. The effect of ESE on entrepreneurial intentions (*coeff*. = .33, *SD* = .10) had a confidence interval excluding zero, CI = [.13, .54].

multiple businesses (Westhead & Wright, 1998), so an examination of the factors that influence the intention to do so is both important and ecologically valid. Second, businesses created by portfolio entrepreneurs tend to have higher growth and may produce more wealth than those founded by first-time entrepreneurs (Westhead, Ucbasaran, Wright, & Binks, 2005), making the drivers of practicing entrepreneurs' intentions particularly important for economic and societal welfare. Third, the question of whether sleep problems affect practicing entrepreneurs' intentions is theoretically interesting, as there are reasons to expect either weaker or stronger effects. On the one hand, practicing entrepreneurs have a greater appreciation for the challenges associated with entrepreneurship (Westhead et al., 2005) and may thus discount intentions attributable to sleep problems. In addition, the decision to open up an additional business might carry greater opportunity costs, as a new business would divert resources from existing businesses (for portfolio entrepreneurs with an ownership stake in several going concerns) or even require their closure (for serial entrepreneurs who would divest from a startup before proceeding to the next).

On the other hand, theory provides several reasons to suspect that sleep problems and ADHD-like tendencies might be even more relevant to the development of practicing entrepreneurs' intentions. First, many practicing entrepreneurs experience problematic sleep (e.g., Guiliani & Torres, 2018) and display ADHD-like tendencies (e.g., Verheul et al., 2015), so these factors may play an outsized role in catalyzing these individuals' ongoing entrepreneurial intentions. Second, individuals generally found businesses when doing so seems both feasible and desirable (Shapero, 1982), and prior entrepreneurial experience (especially when positive) is associated with increases in both perceived feasibility and desirability (Krueger, 1993). If practicing entrepreneurs are already more inclined to venture than others, then the nudge provided by sleep problems and ADHD-like tendencies could have an even stronger influence on

their entrepreneurial intentions. In sum, we examined the hypotheses among practicing entrepreneurs because the sources of their intentions are crucial, but theory produces intriguingly divergent predictions about the influence of their sleep problems and ADHD-like tendencies. Study 4 sought to empirically pit those predictions by sampling practicing entrepreneurs and examining whether our effects do or do not extend to this group.

STUDY 4

Method and Measures

Participants. Participants were a multi-national panel of 184 practicing entrepreneurs recruited from a mailing list maintained by a business planning software company on the U.S. West Coast. The CEO of the software company emailed the list, inviting recipients to participate in a study on entrepreneur decision-making (with no mention of sleep or ADHD) and providing a survey link. Of the 252 entrepreneurs who initially clicked-through to participate, 34 failed to answer any questions, and another 34 did not finish the survey. These 68 are excluded from our analyses, and the 34 who started the survey did not differ from the final sample in sleep problems (i.e., sleep quality [p = .22], insomnia [p = .58], sleep quantity [p = .86]), which were the initial scales in the survey. Study participants run small- to medium-sized businesses in Asia (10.9%), Africa (28.3%), North America (47.3%), South America (3.3%), Europe (8.2%), and Australia (2.2%). At the time of the survey, the individuals in our sample had started 2.2 businesses (SD = 1.9) and been self-employed for 7.4 years (SD = 13.6). On average, they were 43 years old (SD = 13.7); 62.3% were male; and 52.4% held at least a four-year degree. Consistent with our assumptions, 60.9% indicated that they intended to found another business.

Procedure. Participants answered similar questions about their sleep and ADHD-like tendencies, as well as an adapted, parallel entrepreneurial intentions measure gauging their intentions to start another business. Demographic data was obtained at the end of the survey.

Sleep problems. Sleep quality (α = .73), insomnia (α = .70), and sleep quantity were measured as in Study 3 (see Appendix B).

ADHD-like tendencies. Participants completed the ASRS-6 (Kessler et al., 2005) used in Study 3; the reliability in this study was modest (α = .64).

Entrepreneurial intentions. Participants completed an adaptation of the entrepreneurial intentions scale from Studies 2-3 (Zhao et al., 2005). Since these participants had already started businesses, the survey items asked about starting an additional business in the next 5-10 years.

Control variables. As in the prior study, we controlled for participant chronotype and ESE. Since these individuals (unlike the prior participants) were experienced entrepreneurs and experience may relate to entrepreneurial intentions (Farmer, Yao, and Kung-Mcintyre, 2011), this study also controlled for entrepreneurial experience, in number of self-employed years. Finally, given the varying nationalities and English language proficiency of these entrepreneurs, we controlled for English language proficiency.

Results

To test the prediction that ADHD-like tendencies mediate the relationship between sleep problems and entrepreneurial intentions, we ran the same three mediation models as in Studies 2-3 (using the same PROCESS Macro). Overall, these models supported all four hypotheses for all three measures of sleep problems (see Table 1).

As indicated in Table 1, more ADHD-like tendencies were associated with greater entrepreneurial intentions (H1), lower sleep quality was associated with more ADHD-like

tendencies (H2), and ADHD-like tendencies mediated the relationship between sleep quality and entrepreneurial intentions (H3-H4; *coeff.* = -.03, CI = [-.111, -.005]). Likewise, in the model with insomnia, more ADHD-like tendencies were associated with greater entrepreneurial intentions (H1), more insomnia was associated with more ADHD-like tendencies (H2), and ADHD-like tendencies mediated the relationship between insomnia and entrepreneurial intentions (H3-H4; *coeff.* = .06, CI = [.008, .162]). A parallel pattern emerged in the model with sleep quantity (H1-H4; *coeff.* = -.02, CI = [-.071, -.001]). These results support all four hypotheses, suggesting that these relationships extend to real entrepreneurs considering whether to found another business.

Discussion

This study replicated and extended the results of the first three studies among a multi-national sample of practicing entrepreneurs. In support of H1-H4, the results revealed consistent links between all three measures of sleep, ADHD-like tendencies, and entrepreneurial intentions—in this case, intentions to found another business. The results from this study (like Studies 2-3) are cross-sectional rather than causal in nature, and inferring a causal order among individuals already engaged in entrepreneurship may be particularly risky. Nevertheless, the causal evidence in Study 1 and prior studies of ADHD and entrepreneurship affords some confidence about the directionality of the effects. Based on accumulating evidence, then, we suggest that sleep problems may nudge people toward entrepreneurial venturing by heightening their entrepreneurial intentions, even among individuals who understand the inherent challenges.

Mini Meta-Analysis

As a way of testing our hypotheses holistically, we followed Goh, Hall, and Rosenthal's (2016) recommendation to conduct a mini meta-analysis of our studies (cf. Itzchakov & Latham, 2018). Following Goh et al., we performed a separate random-effects meta-analysis for each

regression path in our model (testing H1-H3). Additionally, we computed pooled descriptive statistics and correlations across studies (see Table 2). Studies 2-4 plus the study in Appendix C measured the path from ADHD-like tendencies to entrepreneurial intentions (H1; $k = 4$, $N = 993$). Across studies, greater ADHD-like tendencies reliably related to greater entrepreneurial intentions ($M_r = .08$, $Z = 2.63$, $p = .008$, CI = [.02, .15], $I^2 = 15.69$). All of our studies measured the path from sleep problems to ADHD-like tendencies (H2; $k = 5$, $N = 1344$). Across studies, greater sleep problems reliably related to greater ADHD-like tendencies. Insomnia showed the greatest mean effect sizes ($M_r = .42$, $Z = 16.39$, $p < .001$, CI = [.38, .47], $I^2 = 59.88$), followed by sleep quality ($M_r = .33$, $Z = 12.49$, $p < .001$, CI = [.28, .34], $I^2 = 83.49$), and sleep quantity ($M_r = .128$, $Z = 4.70$, $p < .001$, CI = [.08, .18], $I^2 = 93.91$). Finally, Studies 2-4 plus the study in Appendix C measured the path from sleep problems to entrepreneurial intentions (H3; $k = 4$, $N = 993$). Across studies, greater sleep problems reliably related to greater entrepreneurial intentions: insomnia ($M_r = .10$, $Z = 3.04$, $p = .002$, CI = [.04, .16], $I^2 = 50.66$), sleep quality ($M_r = .09$, $Z = 2.67$, $p = .007$, CI = [.02, .15], $I^2 = 21.80$), sleep quantity ($M_r = .09$, $Z = 2.77$, $p = .005$, CI = [.03, .15], $I^2 = 66.54$). Overall, these results consistently support our hypotheses across studies.

GENERAL DISCUSSION

Despite an increasing scholarly recognition that ADHD-like tendencies may heighten entrepreneurial intentions, we know little about the sources of these tendencies—and thus about the factors that might heighten entrepreneurial intentions through these tendencies in the real world. Building from the biopsychosocial model (e.g., Engel, 1977), sleep physiology literature (e.g., Krause et al., 2017), and entrepreneurship literature (e.g., Shapero, 1982), our paper highlighted a ubiquitous biological factor—sleep problems—that might drive ADHD-like tendencies and nudge people toward entrepreneurship. Four studies supported these predictions,

adding several counterintuitive twists to the entrepreneurship literature and highlighting some important nuances for the way social commentators, entrepreneurship instructors, and prospective entrepreneurs think about sleep problems. We now review these theoretical and practical implications, discussing future directions and limitations.

Theoretical Implications and Future Research Directions

The current research contributes to the entrepreneurship literature, first, by documenting that the biological experience of sleep problems may influence the psychological experience of ADHD-like tendencies—and thus the socially-embedded intention to venture. In so doing, our work surfaces and seeks to answer an important question from the literature on sleep and ADHD: Do impermanent sleep problems causally elicit ADHD-like tendencies among nonclinical adults? Our integration of discrete behavioral findings from sleep physiology research suggests they should, and our empirical studies suggest they do. Additionally, our work surfaces and seeks to answer a new question that has not been empirically examined before: Do impermanent sleep problems directly or indirectly heighten entrepreneurial intentions? The prediction above along with our theory on the relationship between sleep problems and the SEE model suggests they should, and our empirical studies again suggest they do. Collectively, these contributions advance theory and extend our empirical understanding of sleep, ADHD, and entrepreneurship.

More generally, by integrating insights from entrepreneurship research with the biopsychosocial model and sleep physiology literature, we add a biological factor to the "left side" of models predicting entrepreneurial intentions with psychological antecedents. Sleep is a critical biological factor on its own, as sleep problems are ubiquitous and pose a grave threat to health and well-being (e.g., NIOSH, 2004). Yet, sleep is but one biological factor that might influence the psychological antecedents of entrepreneurial intentions. How might other such

factors like exercise or addiction shape entrepreneurial intentions, through ADHD-like tendencies or other psychological tendencies? Conversely, what other types of non-routine activities might sleep problems prompt (as suggested by the results in Appendix C)?[5] The current research cannot answer all such questions, but it opens the door to research that does.

Importantly, we study not just sleep problems but *impermanent* sleep problems. Paralleling the entrepreneurship literature's recent focus on ADHD-like tendencies, we show that even short-lived sleep problems (e.g., one night in Study 1) are sufficient to heighten these tendencies. This matters for at least three reasons: First, since almost everyone suffers sleep problems on occasion (Barnes, 2012) whereas true sleep disorders are far less common (Cleveland Clinic, 2019), our results may apply to much of society. Second, a focus on impermanent sleep problems allows us to extend the small but growing literature on situational drivers of entrepreneurial intentions. Alongside factors like work experiences (Lee, Wong, & Der Foo, 2011), salient role identities (Mathias & Williams, 2017), and variations in physical health (Shepherd & Patzelt, 2015), impermanent sleep problems may nudge people toward entrepreneurship—and do so for limited but consequential periods of time like weeks or months. Third, existing research on biological drivers of entrepreneurship has predominantly focused on stable biological factors like genetic dispositions (Nicolaou et al., 2008) or neurodevelopmental disorders (Wiklund et al., 2017). Our results open the door to research on more situational biological influences, which matter because they are inherently more variable. Ultimately, research may wish to consider the interaction between state-like influences like sleep problems and stable factors, examining, for example, whether people with a genetic predisposition toward entrepreneurship ultimately act when experiencing sleep problems.

[5] Thank you to an anonymous reviewer for this interesting idea.

Most importantly, we hope that the current research sparks a nuanced and balanced discussion about the effects of society's increasing sleepiness on entrepreneurship—be they negative or positive. On the negative side, sleep problems that continue unabated after the formation of entrepreneurial intentions could clearly "come back to haunt" individuals who choose to venture. Indeed, the formation of entrepreneurial intentions is but one early stage in the entrepreneurial journey, followed by an extended series of development and implementation activities (McMullen & Dimov, 2013). Given the deleterious effects of sleep problems on many competencies required of successful entrepreneurs (e.g., Gish et al., 2019; Murnieks et al., 2019; Weinberger et al., 2018; Williamson et al., 2019), ongoing sleep problems could eventually lead to a "sleep trap" (Gunia, 2018) whereby individuals lured into entrepreneurship on the basis of sleep problems perform poorly if those problems continue. Future research might investigate possible negative effects of sleep problems in later stages of the entrepreneurial process.

A balanced discussion of sleep problems' effects, however, might also take account of their potential positive implications. Theoretically consistent with both SEE (Shapero, 1982) and accumulating evidence that a-rational impulses complement rational deliberation by nudging people to take entrepreneurial action, our results suggest that impermanent sleep problems may prompt people to perceive existing entrepreneurial ideas as relatively feasible and desirable—and ultimately to act on them. If so, then sleep problems may, in aggregate, contribute to heightened rates of business founding (i.e., increase the quantity of entrepreneurial ventures), which has been linked to numerous societal benefits including but extending beyond wealth creation (e.g., Acs, 1999; Hitt et al., 2011; Markman et al., 2019). Thus, although we would not glorify sleep problems, we would tentatively conclude that they may hold a specific benefit for society by providing an additional a-rational source of venturing (Hunt & Lerner, 2018).

Will the positive or negative implications of sleep problems for entrepreneurship predominate? Ultimately, the answer may come down to three considerations. First, to what extent do impermanent sleep problems continue through the entrepreneurial journey and impact entrepreneurs' longer-term performance? Evidence on the sleeplessness of practicing entrepreneurs is distinctly mixed (Wolfe & Patel, 2019), and despite work showing that sleep problems hinder several entrepreneurial competencies, evidence on the actual performance implications of sleep problems for practicing entrepreneurs is rare. Second, and assuming sleep problems do continue and hamper entrepreneurial performance, their net effects may depend on whether entrepreneurs can mitigate such problems, e.g., by curing them, working with well-rested business partners, or proactively seeking feedback. Research is needed to determine what strategies might allow entrepreneurs to benefit from the initial nudge afforded by sleep problems without suffering a sleep trap. Finally, the net effects of sleep problems may depend on whether the increased quantity of entrepreneurial ventures attributable to sleep problems is similar in quality.[6] No known research has investigated the influence of sleep problems on the quality of an entrepreneur's own ideas or businesses. If sleep problems and their absence favor the implementation of comparable ideas, which seems possible when these ideas arise before the onset of the sleep problems, then certain societal benefits might materialize.

In sum, sleep problems represent an increasing reality around the world, so their effects on entrepreneurship and other behaviors deserve objective scientific study. Although we allow for a sleep trap if entrepreneurs' sleep problems persist unabated throughout the entrepreneurial journey, our research indicates that sleep problems may provide an initial nudge people toward

[6] Thank you to an anonymous reviewer for helping us make the distinction between quality and quantity.

entrepreneurship, with possible societal benefits. Unpacking the full suite of entrepreneurial costs and benefits associated with sleep problems represents fertile territory for future research.

Practical Implications

The current research also holds some potentially important implications for practice. First, it suggests that social commentators may wish to reconsider whether impermanent sleep problems are "all bad," despite the gravity of true sleep disorders and the potential consequences of even impermanent sleep problems on longer-term entrepreneurial performance. While such a view is controversial, it may contribute to the de-stigmatization of individuals whose social or personal circumstances place healthy sleep out of reach. Perhaps our findings can contribute to greater social acceptance of diversity in sleep patterns.

Second, the current research suggests that entrepreneurship instructors may wish to consider expanding the way they train entrepreneurs. Much current training seeks to develop important entrepreneurial competencies and foster the identification and exploitation of business opportunities in general. The current research suggests that instructors may wish to supplement these topics with a discussion of the potentially varying nature of entrepreneurial intentions—the idea that prospective entrepreneurs may feel more entrepreneurial in some periods than others. Even without any discussion of sleep problems, simply validating variation in entrepreneurial intentions over time and teaching individuals that entrepreneurial intentions are more likely to emerge in certain circumstances may help them deal with doubts and leverage their less judgment-driven and more a-rational tendencies (Hunt & Lerner, 2018).

Finally, and as noted, our research holds implications for prospective entrepreneurs. In view of a potential sleep trap (Gunia, 2018), individuals considering entrepreneurship should not actively deprive themselves of sleep. Still, many prospective entrepreneurs, like others, may be

unable to avoid at least impermanent sleep problems (Wiklund et al., 2016). The current research suggests that, for these individuals to reap any benefits from sleep problems, they may need to manage such problems carefully. In particular, prospective entrepreneurs who are suffering sleep problems may wish to reevaluate their entrepreneurial ideas after treating or overcoming their sleep problems, or at least after engaging in compensatory activities like mindfulness exercises (Murnieks et al., 2019). Alternatively, such individuals may wish to seek out well-rested partners who can complement their tendency toward a-rational action. At a minimum, they may wish to seek out well-rested advisors who can offer frank feedback on the wisdom of their ideas. Taken together, steps like these may help to mitigate some of the risks associated with sleep problems while preserving their potentially beneficial nudge. In sum, the current research suggests a variety of counterintuitive modifications to the way social commentators, instructors, and prospective entrepreneurs think about sleep problems—none of which glorifies sleep problems but all of which provide hints about how to channel and manage them productively.

Limitations

Like all research, ours has limitations that may stimulate future research. First, although Study 1 used an experimental design that allowed for strong causal claims about the relationship of interest, our remaining studies used cross-sectional designs. Future research that manipulates sleep and measures both ADHD-like tendencies and entrepreneurial intentions (as the study in Appendix C sought to do) could usefully complement these studies. Indeed, we see a full-scale longitudinal study of all core constructs as a critical next step. Second, we acknowledge that we have studied intentions rather than actual venturing. Although a connection between intentions and action is consistent with theories like SEE (Shapero, 1982), and many who express intentions do become entrepreneurs (Kautonen, van Gelderen, & Fink, 2015), not all do, and the

role of ADHD in this process is currently unknown. Third, and relatedly, we theorized about but did not include measures of the mediating processes proposed by SEE (e.g., desirability, feasibility). We would urge future research to measure and examine these potential mediating processes in tandem with ADHD-like tendencies. Fourth, although the study results generally supported the hypotheses, and the mini meta-analysis suggested some consistency across sleep measures, the specific effects varied somewhat across individual studies. For example, sleep quality emerged as a significant predictor across all studies, while sleep quantity sometimes did not. We wonder about the source of the inconsistency, and especially whether our diverse populations with their differing cultures and types of entrepreneurial experience were experiencing different types of sleep problems, which had different effects. Finally, we acknowledge that circadian process make our findings somewhat sensitive to the time-of-day at which they were measured. Although environmental signals impose some consistency in circadian rhythms across individuals and we would not expect systematic biases in the results, the effect of sleep problems may have been relatively stronger (weaker) among those experiencing a pronounced trough (peak) at the time of the study. Future research that disentangles the effect of circadian and homeostatic processes in the entrepreneurship domain, as research in other organizational domains has done (e.g., Gunia et al., 2014), could be fruitful.

Conclusion

The current research sought to connect the contemporary prevalence of sleep problems to the enduring allure of entrepreneurship. Extending prior work on the link between ADHD-like tendencies and entrepreneurial intentions, we suggested that sleep problems can elicit the former and heighten the latter. We hope these surprising results motivate more work into the many biological influences that could nudge people toward the consequential choice to venture.

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FIGURE 1

Conceptual Model

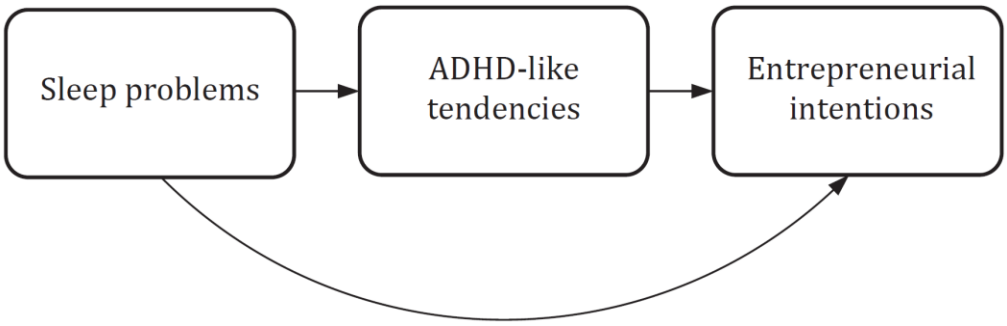
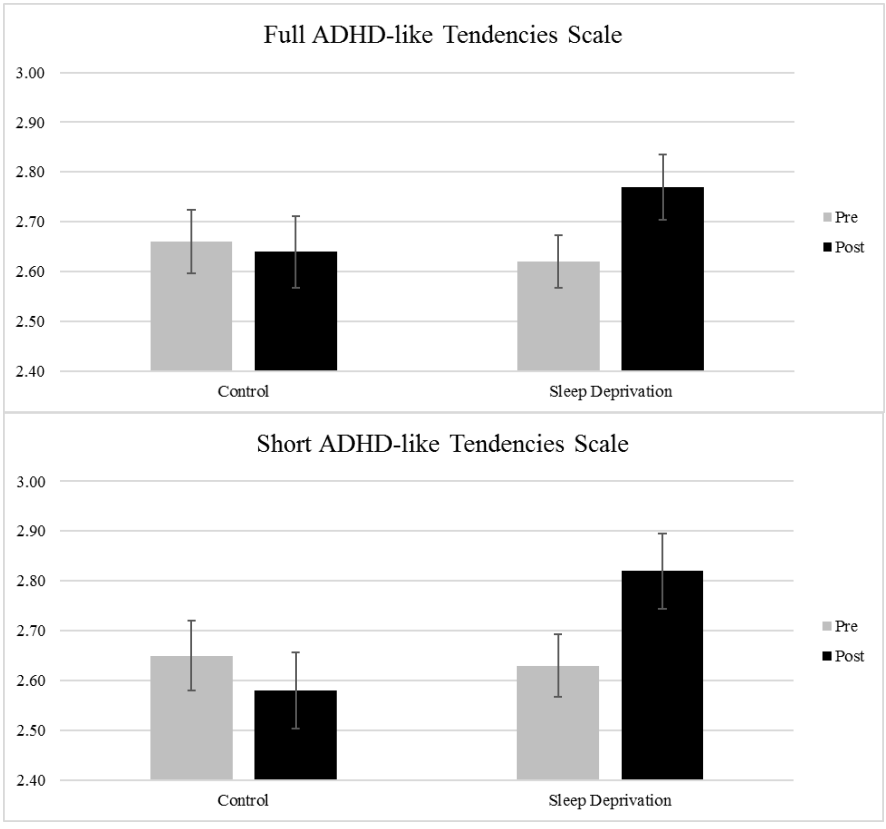


FIGURE 2

Study 1 Results



Note. These figures exclude participants in the Sleep Deprivation condition who failed the manipulation check, and they include a randomly selected subset of participants in the Control condition (matched to the number of participants in the Sleep Deprivation condition). Sleep Deprivation vs. Control was manipulated between-subjects, and Pre vs. Post refer to measurements taken within-subjects before or after the between-subjects manipulation.

TABLE 1

Study 4 Mediation Model Results

Model	1. Sleep quality		2. Insomnia		3. Sleep quantity	
Outcome	ADHD	EI	ADHD	EI	ADHD	EI
Sleep	-.10†	.06	.22***	.10	-.08†	-.22**
ADHD	–	.34*	–	.29*	–	.28*
Indirect effect	-.03*		.06*		-.02*	
[95% CI]	[-.111, -.005]		[.008, .162]		[-.071, -.001]	

Note. † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. ADHD = ADHD-like tendencies; EI = Entrepreneurial intentions. Each model employs a different measure of sleep. The indirect effect represents the effect of sleep on entrepreneurial intentions, through the proposed mediator, ADHD-like tendencies.

TABLE 2

Descriptive Statistics and Correlations for All Studies Pooled

	M	*SD*	(1)	(2)	(3)	(4)	(5)
1. Entrepreneurial intentions (Z-score)	0.00	1.00	–				
2. ADHD-like tendencies (Z-score)	0.00	1.00	.08*	–			
3. Sleep quality	3.19	1.10	-.01	-.31***	–		
4. Insomnia	2.52	1.04	-.002	.41***	-.77***	–	
5. Sleep quantity	6.65	1.67	-.07*	-.13***	.36***	-.35***	–
6. Chronotype	4.20	2.20	.01	.11***	-.08**	.10***	.004

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. These descriptive statistics and correlations are generally based on the 1344 participants in Studies 1-4 as well as the replication and extension study in Appendix C. Since Study 1 did not contain a measure of entrepreneurial intentions, N = 993 for entrepreneurial intentions and its correlations. *Z*-scores were computed for entrepreneurial intentions and ADHD-like tendencies due to differing measures across studies.

APPENDICES

Appendix A: Study 1 Instructions

Sleep Deprivation Condition

You have been assigned to the group that will answer survey questions throughout the night. Starting at 10:00 PM, you will receive an email with a link to a very brief survey that asks you a few questions. You must answer this very brief survey within 15 minutes of receipt.

You will receive a total of ten of these brief survey emails each hour throughout the night, one each hour on the hour (e.g., 10:00 PM, 11:00 PM, 12:00 AM...7:00 AM). Then you will answer one final survey with a different set of questions at 8:00 AM tomorrow morning.

If you feel you will not be able to meet these conditions, please notify the survey administrator by emailing [email address].

Your total compensation for participation will be $8 (about 6.14 GBP), contingent on your completion of this survey, 7 of 10 overnight surveys, and tomorrow morning's survey at 8:00 AM. As a reminder, you will be paid in two installments (a base rate and a bonus).

Note that you will receive a completion code after the current survey, but your submission will be rejected if you do not answer at least 7 of 10 overnight surveys as well as the additional survey at 8:00 AM tomorrow morning.

Control Condition

You have been assigned to the group that will NOT answer survey questions throughout the night. You will receive a message with a survey link tomorrow morning at 8:00 AM. You need to answer this survey within 15 minutes of receipt so that your timing closely matches the other group of participants.

We ask that you sleep your normal amount before the completion of tomorrow morning's survey.

If you feel you will not be able to meet these conditions, please notify the survey administrator by emailing [email address].

Your total compensation for participation will be $2 (about 1.54 GBP), contingent on your completion of this survey and tomorrow morning's survey at 8:00 AM.

Note that you will receive a completion code after the current survey, but your submission will be rejected if you do not answer the additional survey at 8:00 AM tomorrow morning.

Appendix B: Sleep Measures across all Primary Studies

Study 1 Pre-Survey

Please answer the questions below about your sleep patterns, selecting the option that best describes how you have slept over the past 6 months. Please answer openly and honestly; your responses are anonymous and will be held in strict confidence.

- How well do you usually sleep? (Very Poorly, Poorly, Neither Poorly Nor Well, Well, Very Well)
- How soundly do you usually sleep? (Very Restlessly, Restlessly, Neither Restlessly Nor Soundly, Very Soundly)
- To what extent do you usually experience the following symptoms at night? (Very Slightly or Not At All, A Little, Moderately, Quite A Bit, Very Much)
    - Have trouble falling asleep
    - Have trouble staying asleep (including waking up too early)
    - Wake up several times throughout the night
    - Wake up after your usual amount of sleep feeling tired and worn out
- Please fill in the times for each of the following events.
    - What time do you usually go to bed? Please select the closest time from the drop-down list below.
    - After going to bed, how many minutes does it usually take for you to fall asleep? Please enter a number of minutes.
    - After initially falling asleep, how many minutes do you usually spend awake? For example, if you fall asleep at 11:00 pm, wake at 1:30 am for 10 minutes, and then sleep through the rest of the night your answer would be 10. Please enter a number of minutes.
    - What time do you usually finally wake this morning? Please select the closest time from the drop-down list below.

Study 1 Post-Survey

Please answer the questions below about your sleep last night, selecting the option that best describes how you slept last night. Please answer openly and honestly; your responses are anonymous and will be held in strict confidence.

- How well did you sleep last night? (Very Poorly, Poorly, Neither Poorly Nor Well, Well, Very Well)
- How soundly did you sleep last night? (Very Restlessly, Restlessly, Neither Restlessly Nor Soundly, Very Soundly)
- To what extent did you experience the following symptoms last night? (Very Slightly or Not At All, A Little, Moderately, Quite A Bit, Very Much)
    - Had trouble falling asleep
    - Had trouble staying asleep (including waking up too early)
    - Woke up several times throughout the night
    - Woke up after your usual amount of sleep feeling tired and worn out
- Please fill in the times for each of the following events.

- What time did you go to bed last night? Please select the closest time from the drop-down list below.
- After going to bed, how many minutes did it take for you to fall asleep? Please enter a number of minutes.
- After initially falling asleep, how many minutes did you spend awake? For example, if you fell asleep at 11:00 pm, woke up at 1:30 am for 10 minutes, and then slept through the rest of the night your answer would be 10. Please enter a number of minutes.
- What time did you finally wake this morning? Please select the closest time from the drop-down list below.

Study 2
Same as Study 1 Pre-Survey

Study 3
Same as Study 1 Pre-Survey except sleep quantity questions replaced with:

- How many hours do you usually sleep? Please select a number. (0-16 in half-hour increments)

Study 4
Same as Study 3

Appendix C: Study 1 Replication and Extension

To ensure that sleep problems influence experienced rather than just anticipated ADHD-like tendencies, we sought to replicate Study 1 using a retrospective measure of those tendencies. Additionally, to examine our full causal model, we included a measure of entrepreneurial intentions. Finally, to examine whether the effects of sleep problems are restricted to entrepreneurial intentions, we measured individuals' intention to engage in other non-routine behaviors. Otherwise, the current study was very similar to Study 1. Thank you to the review team for encouraging us to run this study.

Method

Participants, design, and procedure. Based on the dropout rates in Study 1, we set the *a priori* goal of recruiting 550 participants in the U.K. from Prolific Academic. We paid them $2 more in both conditions ($4 in the Control and $10 in the Sleep Deprivation condition) to account for the longer duration of the study. Unless otherwise noted, all analyses were performed on the subset of participants described in Study 1 (everyone in the Control condition and those in the Sleep Deprivation condition who reported being awake for at least 30 minutes).

Participants followed essentially the same procedure as in Study 1 with several exceptions. First, they completed the post-survey at 7:00 pm rather than 8:00 am of the second day, which allowed them to reflect on the ADHD-like tendencies they had experienced that day rather than anticipating the tendencies they would display over that day. Second, in both the pre- and post-survey, participants completed some additional questions as detailed below.

Measures

Sleep problems (pre- and post-surveys). Participants completed the same sleep measures as in Study 1 (sleep quality: $\alpha_{pre} = .79$, $\alpha_{post} = .89$; insomnia: $\alpha_{pre} = .72$, $\alpha_{post} = .78$).

ADHD-like tendencies (pre- and post-surveys). In the pre-survey, participants completed the same ADHD-like tendencies measure as in Study 1 ($\alpha = .88$). In the post-survey, the measure was adapted to refer to ADHD-like tendencies over the previous day ($\alpha = .89$; e.g., "Did you have problems remembering appointments or obligations?"; 1 = Definitely not, 5 = Definitely). Since some items refer to experiences participants may not have had on a particular day, we adapted these items to refer to the way participants would have behaved (e.g., "Would you have had trouble wrapping up the final details of a project, once the challenging parts were done?"). The exact wording of the questions is available on request.

Entrepreneurial intentions (pre- and post-surveys). During both the pre- and post-survey, participants completed adaptations of both the attitudes and the intentions portions of the validated Entrepreneurial Intentions Questionnaire (EIQ; Moriano, Gorgievski, Laguna, Stephan, Zarafshani, 2012). Because this measure is prospective, the pre-survey version was adapted to use retrospective language (e.g., "In the past, to what extent has creating a new company or becoming an entrepreneur meant for you...facing new challenges?"; 1 = Not at all, 7 = To a very great extent). The post-survey questions were then adapted slightly to be as consistent as possible with both the pre-survey and the validated measure (e.g., "Looking forward, creating a new company or becoming an entrepreneur would mean for you..."; 1 = Totally improbable, 7 = Totally probable; $\alpha_{PreAttitudes1} = .90$; $\alpha_{PostAttitudes1} = .87$; $\alpha_{PreAttitudes2} = .81$; $\alpha_{PostAttitudes2} = .79$; $\alpha_{PreIntentions} = .82$; $\alpha_{PostIntentions} = .90$). Full adapted questionnaires are available on request.

Other non-routine activities (pre- and post-surveys). To examine whether sleep problems increase people's intentions to engage in non-routine behaviors beyond entrepreneurship, participants answered two additional questions in the pre- and post-surveys. The pre-survey questions read: "In the past, how willing have you been to study a new subject?"

and “In the past, how willing have you been to pause your current activities and travel around the world?” (1 = Not at all willing, 7 = Very willing). The post-survey questions were similar but asked about “the next five years” (the same referent as some of our entrepreneurship questions). These new questions did not load into scales at either time period and were analyzed separately.

Affect (overnight and post-surveys). Participants completed the same affect measures as in Study 1 (Thompson, 2007; post-survey positive $\alpha = .87$; negative $\alpha = .72$).

Demographics and control variable (pre- and post-surveys). Participants completed the same demographic and control questions as in Study 1.

Results

Sample comparability. Given the long lag between the pre-survey and 7 pm post-survey in this study (up to 36 hours), we were concerned that an even higher proportion of participants in the Sleep Deprivation condition might drop out, potentially leading to demographic differences between conditions and threatening our random assignment procedure. To examine these or any other selection effects attributable to differential dropout, we performed the same set of analyses as in Study 1. In the Control condition, dropout rates were similar to Study 1’s. As suspected, however, dropout rates in the Sleep Deprivation condition were considerably more severe here: About 54% of the participants started the study but did not complete the minimum number of overnight surveys and/or the post-survey. Presumably as a result, the final set of participants in our two conditions differed in pre-existing sleep problems (as measured in the pre-survey): Participants in the Sleep Deprivation condition reported lower pre-treatment sleep quality ($M = 2.87$, $SD = .96$ vs. $M = 3.29$, $SD = .95$; $t(333) = 3.59$, $p < .001$); more insomnia ($M = 3.04$, $SD = .95$ vs. $M = 2.66$, $SD = .92$; $t(333) = 3.26$, $p = .001$); and lower sleep quantity ($M = 6.40$, $SD = 1.48$ vs. $M = 6.86$, $SD = 1.52$; $t(333) = 2.48$, $p = .01$) than those in the Control

condition (though the two conditions did not differ in ADHD-like tendencies [p =.56]; age [p = .28], gender [p = .38], or years speaking English [p = .21]). These differences emerged even though the full set of participants who started (but often did not finish) the study did not differ across conditions in pre-treatment sleep quality (M = 3.22, SD = .99 vs. M = 3.28, SD = .95; t(618) = .77, p = .44); insomnia (M = 2.73, SD = .95 vs. M = 2.68, SD = .95; t(618) = .62, p = .53); or sleep quantity (M = 6.77, SD = 1.81 vs. M = 6.81, SD = 1.97; t(618) = .28, p = .78).

Taken together, these findings suggest that our random assignment procedure initially distributed chronically healthy and unhealthy sleepers across conditions in a random fashion, as intended. However, the overnight surveys in the Sleep Deprivation condition led a disproportionate number of chronically health sleepers to drop out of this condition, either overnight or during the long lag before the 7 pm post-survey. Ultimately, this means that healthy sleepers were underrepresented in the Sleep Deprivation condition, and our ability to draw inferences from random assignment was compromised. In other words, it would not be appropriate to examine differences by condition as we did in Study 1.

Thus, we faced a dilemma as to whether to place this study into the “file drawer” or identify an alternative, albeit imperfect way of testing the hypotheses involving sleep. We chose the latter. Specifically, we sought to conduct two alternative types of analyses. First, we performed the regression equivalent of the Study 1 analyses, treating the post-survey sleep variables rather than the experimental conditions as our independent variables and controlling for the pre-survey sleep variables. These analyses essentially sought to explain our dependent variables by the extent to which participants experienced disrupted sleep during the study. (Using difference scores produces similar or stronger results but creates psychometric problems.) As in Study 1, we also controlled for the pre-survey version of each dependent variable and participant

chronotype. Finally, to account for the fact that participants in the two conditions of the current study had different psychological and physical experiences, we treated experimental condition as an additional control variable. In sum, this approach used analyses as equivalent as possible to Study 1's, but it predicted our dependent variables with sleep disruption rather than experimental condition due to the failure of random assignment.

Second, we attempted to deal with this issue by employing propensity score matching (Austin, 2011; Rosenbaum & Rubin, 1983). This method seeks to create balance between two comparison groups by selecting matching cases from each and assigning a propensity score that corresponds to an individual's likelihood of treatment. Analyzing a matched sample seeks to overcome bias by equating potentially confounding variables across conditions, lending greater confidence that the observed results are due to the treatment (Angrist & Pischke, 2015). Our approach matched the samples on age, gender, and chronotype (matched $N = 366$) and employed the inverse probability of treatment weighting (i.e., the inverse of the case-specific propensity score) in a weighted least squares regression (Caliendo & Kopeinig, 2008; Imbens, 2004).

Given the exploratory nature of both sets of analyses (regression analysis and propensity score matching), we focused on replicating Study 1's test of H2 and examining whether sleep problems relate to entrepreneurial intentions (H3), as well as testing the effect of sleep problems on other non-routine activities.

Regression analysis. H2 suggested that sleep problems would lead to elevated ADHD-like tendencies. As depicted in the table below, all three sleep variables predicted ADHD-like tendencies in the expected direction. That is, disrupted sleep quality, disrupted sleep quantity, and heightened insomnia all predicted more ADHD-like tendencies. This suggests that our Study 1 results were not driven by the prospective nature of the ADHD-like tendencies measure.

H3 suggested that sleep problems would be associated with heightened entrepreneurial intentions. In support, disrupted sleep quality predicted heightened entrepreneurial intentions (see table below); analyses involving the other two sleep variables or the entrepreneurial attitudes questions revealed no significant effects. Finally, the sleep variables did not generally predict participants' intentions to engage in other non-routine activities, arguing against this alternative explanation. The one exception was the relationship between sleep quality and the intention to study a new subject specifically (B = -.22, SE = .08, t = 2.62, p = .009), which indicated that disrupted sleep quality was associated with heightened intentions to study a new subject. This suggests that our effect may be broader than anticipated, which may motivate future research (as mentioned in the General Discussion above).

Propensity score matching. The results from this secondary analysis show that, after matching on potentially confounding variables, being assigned to the Sleep Deprivation condition was associated with a marginally significant increase in post-treatment ADHD-like tendencies (H2; β = 0.14, p = .088). Likewise, being assigned to the Sleep Deprivation condition was associated with an increase in post-treatment entrepreneurial intentions (β = 0.37, p = .042). Although the effect of treatment on ADHD-like tendencies was smaller and outside traditional cutoff levels for statistical significance, these results are consistent with our hypothesized directional effects and potentially reflective of the statistical power lost in matching.

Discussion

This study suggested, using several admittedly suboptimal methods adopted in response to a failure of random assignment, that problems with sleep quality, sleep quantity, or insomnia predict ADHD-like tendencies and entrepreneurial intentions the next day. Thus, our Study 1 results do not appear attributable to the prospective nature of the measure. Additionally, this

study suggested that problems with sleep quality (and potentially quantity) predict forward-looking entrepreneurial intentions.

TABLE

Replication and Extension Study: Regression Analysis

Model	1. Sleep quality		2. Insomnia		3. Sleep Quantity	
	ADHD	EI	ADHD	EI	ADHD	EI
Sleep	-.27***	-.14*	.34***	.02	-.08***	-.03

Replication and Extension Study: Propensity Score Matching

Model	ADHD	EI
Sleep Deprivation condition	.14†	.37*

Note. ADHD = ADHD-like tendencies; EI = Entrepreneurial intentions.

† p < .10, * $p < .05$, ** $p < .01$, *** $p < .001$.